AIRS Research to Operations

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Outline

- AIRS and AMSU instruments in routine operations with no anomalies

- AIRS Data used in operational weather forecasts at NOAA NCEP. Positive impact seen

- AIRS Paving the way for MetOp IASI, NPOESS CrIS, and GOES-R HES Operational Sounders

- Success of AIRS Operations based on early participation by NOAA in the AIRS science team

- AIRS Charter in 1989
    1. Meet NOAA's Operational Requirements
    2. Meet NASA's Research Needs (Backup charts)

AIRS/AMSU/HSB Standard Products

Radiance Products (Level 1B)	RMS Requirement	Current Estimate
AIRS IR Radiance	3%*	<0.2%
AIRS VIS/NIR Radiance	20%	10-15%
AMSU Radiance	0.25-1.2 K	1-2 K
HSB Radiance	1.0-1.2 K	N/A
Standard Core Products (Level 2)		
Cloud Cleared IR Radiance	1.0 K	<1.0 K
Sea Surface Temperature	0.5 K	0.8 K
Land Surface Temperature	1.0 K	TBD (V5)
Temperature Profile	1 K / km	1K / km
Humidity Profile	15% / 2 km	15% / 2km
Total Precipitable Water	5%	5%
Fractional Cloud Cover	5%	TBD (V5)
Cloud Top Height	0.5 km	TBD (V5)
Cloud Top Temperature	1.0 K	TBD (V5)

*Absolute Relative to NIST

Steps Taken to Facilitate Operational Use

- Stable instrument and operations
- Sufficient Pre-flight calibration
- Efficient and simple calibration
- Fast and accurate retrieval algorithms
- NASA L1 Software on NOAA Machines
- NOAA Supports L2 Development
- Adequate documentation
- NASA-appointed NOAA Science Team Members
  - Mitch Goldberg, Eugenia Kalnay, John Le Marshall, Chris Barnet, Larry McMillan, Bob Atlas, David Wark
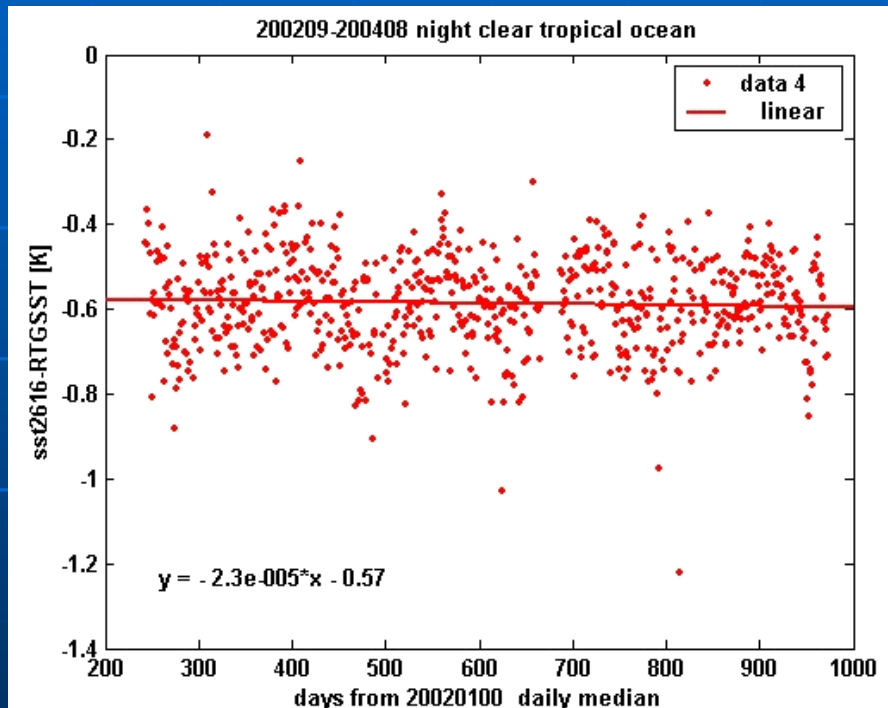
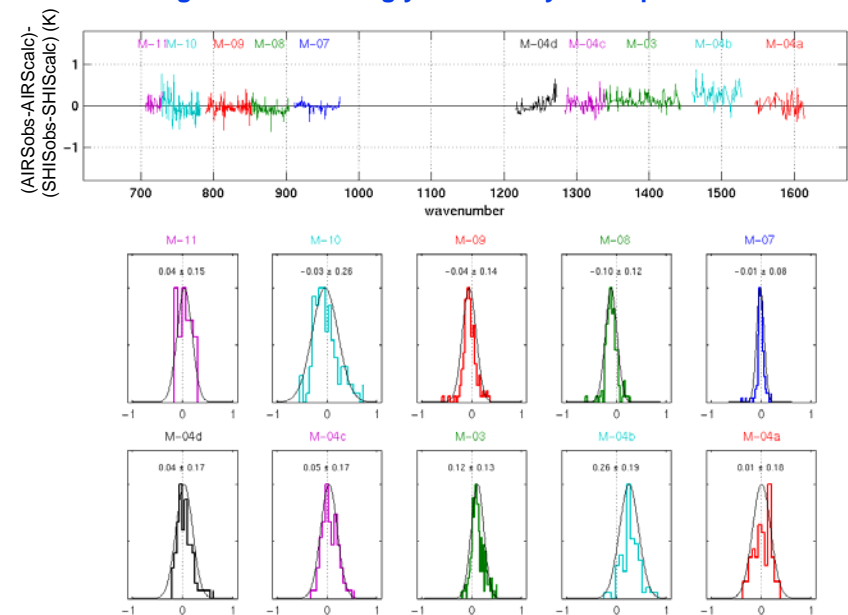# AIRS Level 1 Product Has Shown High Stability and Accuracy

AIRS Comparison with RTG SST Shows < 10 mK Stability

Aumann, H. H. , D. Gregorich, S. Gaiser and M.T. Chahine, "Application of Atmospheric Infrared Sounder (AIRS) Data to Climate Research", Proc. SPIE 5570 Maspalomas, Spain, September 2004

AIRS Comparison with SHIS Shows 0.2K Accuracy

Tobin et al. *Radiometric and Spectral Validation of AIRS Observations with the Aircraft-based Scanning High Resolution Interferometer Sounder*, Submitted JGR, 2006
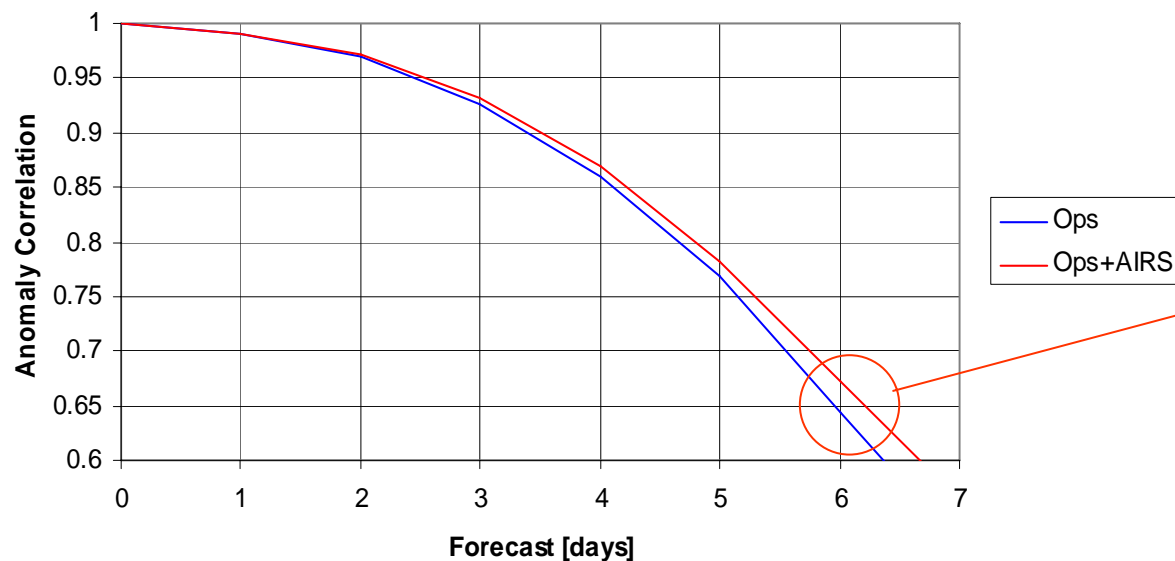
AIRS Radiances Improve Weather Forecasts

N. Hemisphere 500 mb AC Z
20N - 80N   Waves 1-20
1 Jan - 27 Jan '04

John LeMarshall
JCSDA 2005

**Improved Forecast Prediction
(6 hours in 6 Days)
Northern Hemisphere***

"**This AIRS instrument has provided the most significant increase in forecast improvement in this time range of any other single instrument,**"

Retired Navy Vice Admiral Conrad C. Lautenbacher, Jr., Ph.D., under secretary of commerce for oceans and atmosphere and NOAA administrator.

NOAA AIRS Team Awarded Gold Medal

US Department of Commerce Awards Gold Medal to NOAA AIRS/AMSU Team
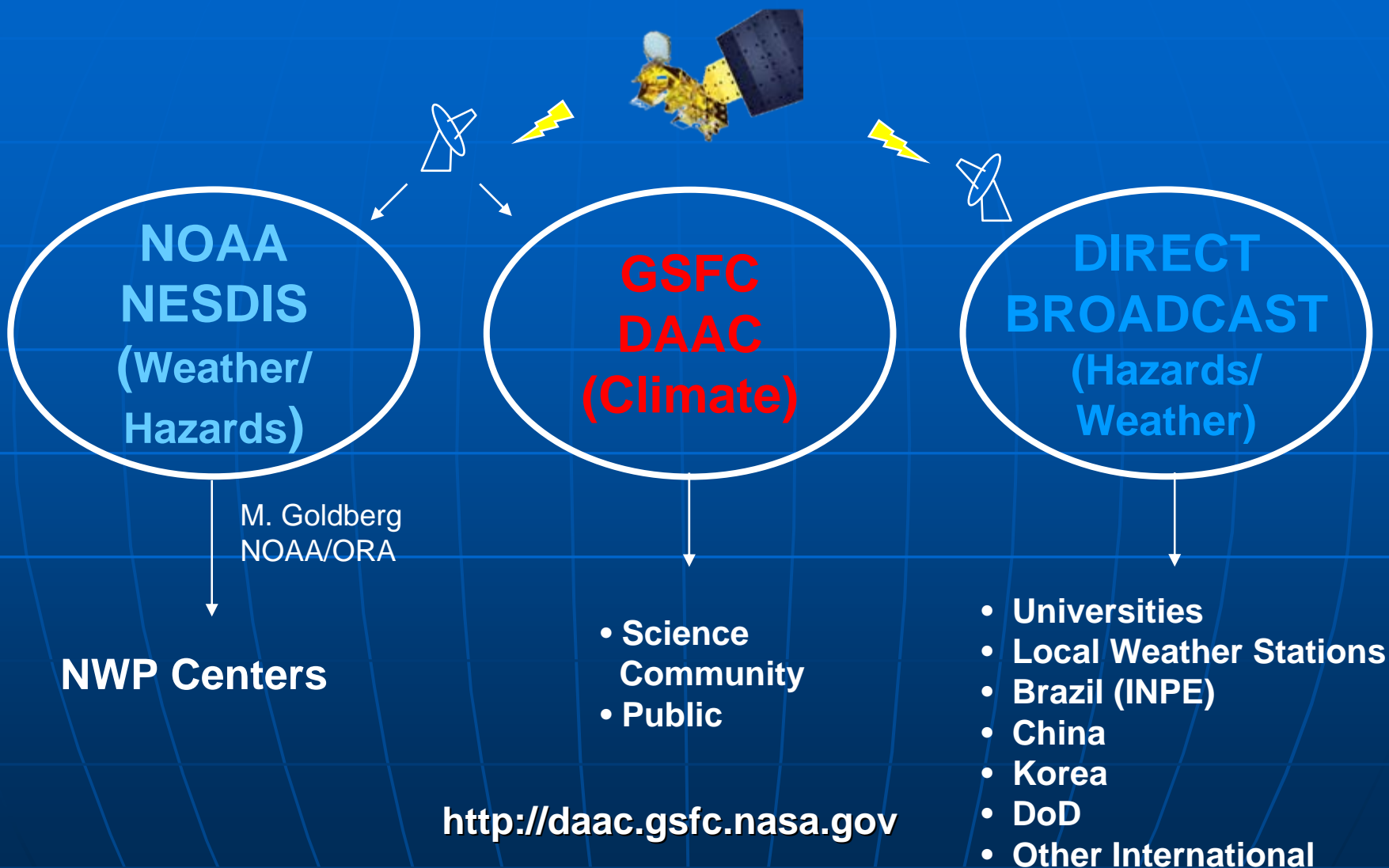

Left to right: Secretary of Commerce Carlos M. Gutierrez, Award Recipients Russ Treadon, John Derber, Larry McMillin, Fuzhong Weng, and Mitch Goldberg, NOAA Administrator Conrad Lautenbacher, and Deputy Secretary of Commerce David A. Sampson.

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AIRS/AMSU Data Distribution Centers

NOAA NESDIS (Weather/ Hazards)

GSFC DAAC (Climate)

DIRECT BROADCAST (Hazards/ Weather)

M. Goldberg
NOAA/ORA

NWP Centers

- **Science Community**
- **Public**

http://daac.gsfc.nasa.gov

- **Universities**
- **Local Weather Stations**
- **Brazil (INPE)**
- **China**
- **Korea**
- **DoD**
- **Other International**

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
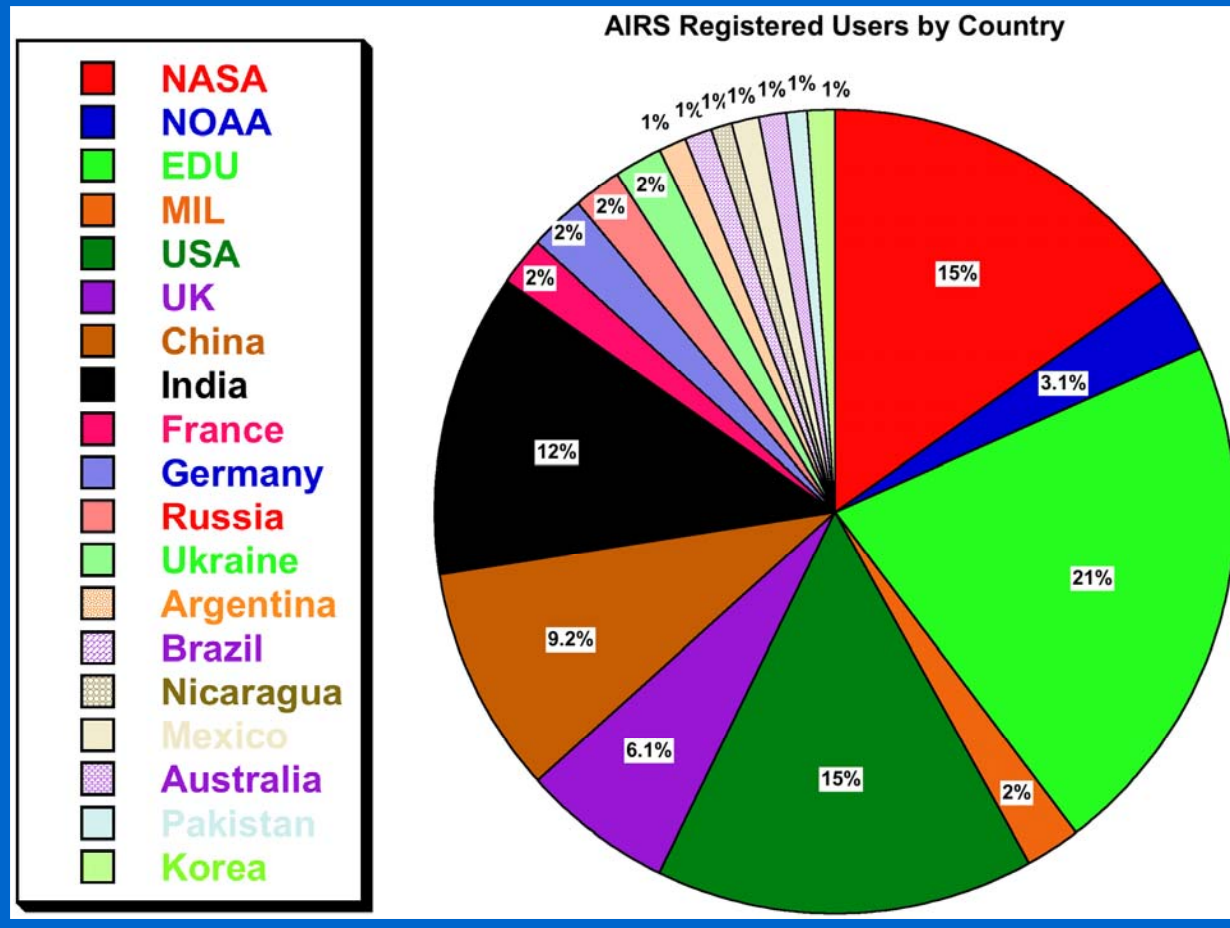Pasadena, California

Other Agency Users of AIRS

NWP Customers

- NCEP
- GMAO (DAO)
- CMC (Canada)
- JMA (Japan)
- FNMOC (US Navy)
- BMRC (Australia)

- UK-Met Office
- ECMWF
- Meteo-France
- DWD (Germany)
- CPC

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AIRS Users Diverse and International

AIRS Registered Users by Country

- NASA
- NOAA
- EDU
- MIL
- USA
- UK
- China
- India
- France
- Germany
- Russia
- Ukraine
- Argentina
- Brazil
- Nicaragua
- Mexico
- Australia
- Pakistan
- Korea

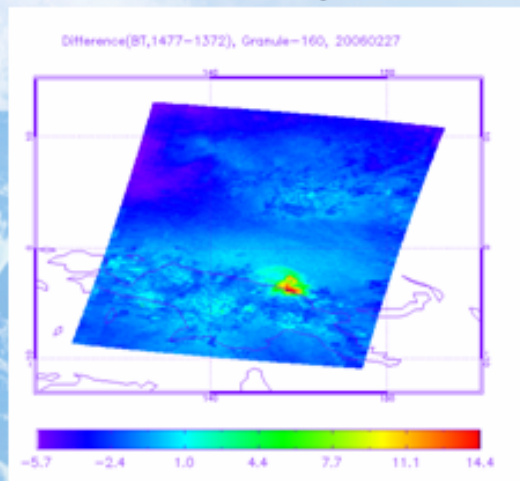• 100 Users Surveyed who made an AIRS data request from the GES DISC
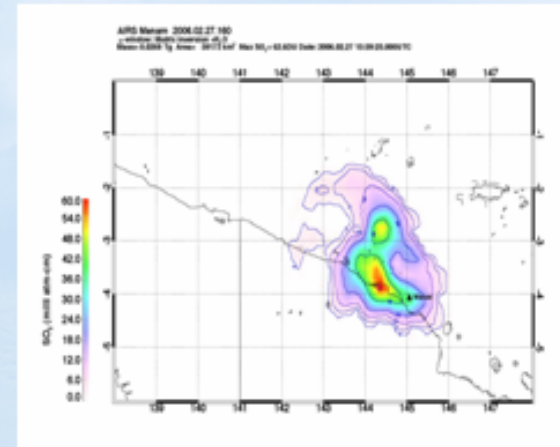
AIRS SO$_2$ Flag Used Operationally

SO2 flag has generated a lot of interest at NOAA and internationally

- Augustine (1/13,14,29/06, 2/7/06) & Manam (2/27-28/06) detected

- Washington Volcanic Ash Advisory Center (VAAC, W-vaac@noaa.gov) requested and now receives and re-broadcasts AIRS SO2 flag.

  - May be used for aircraft early warning.

- Fred Prata, Norwegian Institute for Air Research, is generating SO2 retrievals from AIRS & HIRS - we are working with Fred to incorporate his retrieval into the near real–time system

Difference(BT,1477−1372), Granule−160, 20060227

AIRS SO2 flag

SO2 Retrieval (Courtesy of Fred Prata

Chris Barnet (NOAA)
AIRS Sci Tm (2006)

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National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

NPOESS P³I

Trace Gas Product Potential from Operational Thermal Sounders

gas	Range (cm^{-1})	Precision	Interference	
O_3	1025-1050	10%	H2O,emissivity	Working
CO	2080-2200	15%	H2O,N2O	
CH_4	1250-1370	20 ppb	H2O,HNO3	
CO_2	680-795	2 ppm	H2O,O3	
	2375-2395	2 ppm		
SO_2	1340-1380	1000%	H2O,HNO3	In Work
HNO_3	860-920	40%	emissivity	
	1320-1330	25%	H2O,CH4	
N_2O	1250-1315	10%	H2O	
	2180-2250	10%	H2O,CO	
$CFCl_3$ (F11)	830-860	20%	emissivity	Held Fixed
CF_2Cl (F12)	900-940	20%	emissivity	
CCl_4	790-805	50%	emissivity	

Haskins, R.D. and L.D. Kaplan 1993

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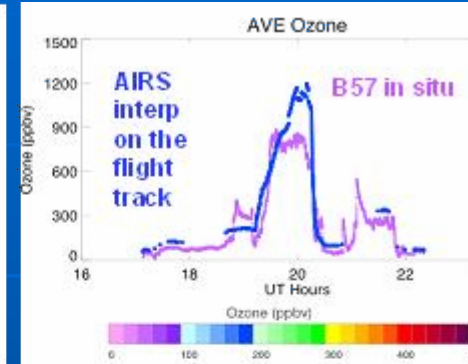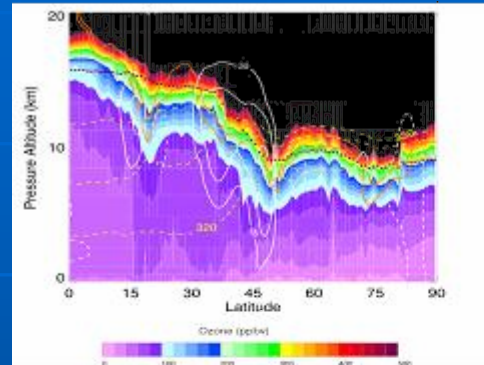Chris Barnet (NOAA)
AIRS Sci Tm (2006)

AIRS Used in Global
Atmospheric Composition Research

O_3 Laura Pan: **NCAR**

- Good vertical resolution near the tropopause
- Validated using Aircraft Data
- High spatial density of sampling allows mapping dynamical variability of UTLS chemical distribution
- Ozone and water vapor are pair of tracers for diagnosing mixing
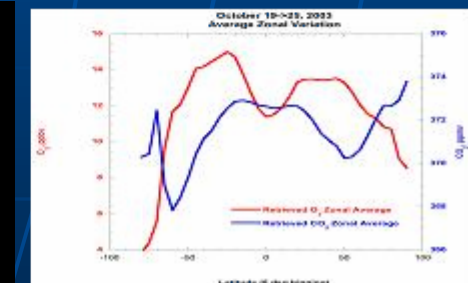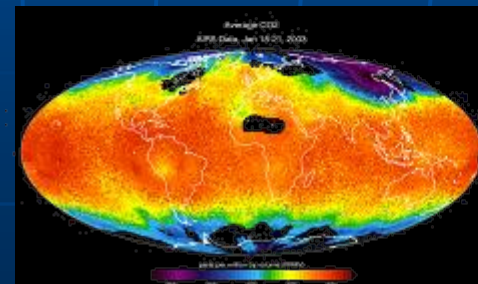
CO Wallace McMillan[7]: **UMBC**

- Good Horizontal Coverage on a Daily Basis
- Validated during INTEX-A: 15%
- Distribution follows Trajectory Models
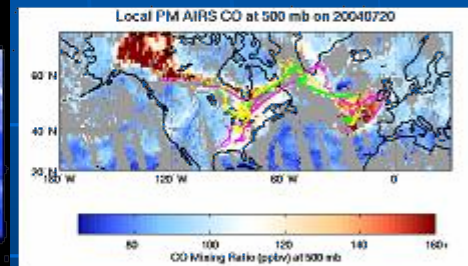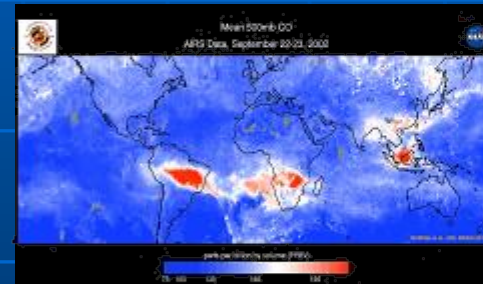
CO_2 Mous Chahine[8]: **JPL**

- Accurate to ±1.2 ppm in Mid Trop.
- Validated using Aircraft (Matsueda)
- Global Maps highlight Brewer-Dobson

CH_4 Chris Barnet: **NOAA**

- NOAA Derived Retrieval
- 26 Months of AIRS CH_4 Available
- Not yet validated

*CO_2-O_3 Anticorrelation (above right) due to intrusion of stratospheric air into the troposphere*

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AIRS Paving the Way for Future Planned Sounders

- ## IASI on METOP
  - AIRS L2 Algorithms
  - AIRS Cross Validation
- ## CrIS on NPP/NPOESS
  - NASA NPP Science Team All AIRS Staff
  - NASA Sounder PEATE based on AIRS
  - AIRS Cross Validation
- ## HES on GOES-R
  - AIRS Data as Proxy to evaluate requirements
  - System Contract Review by AIRS Staff

METOP

NPOESS

GOES-R
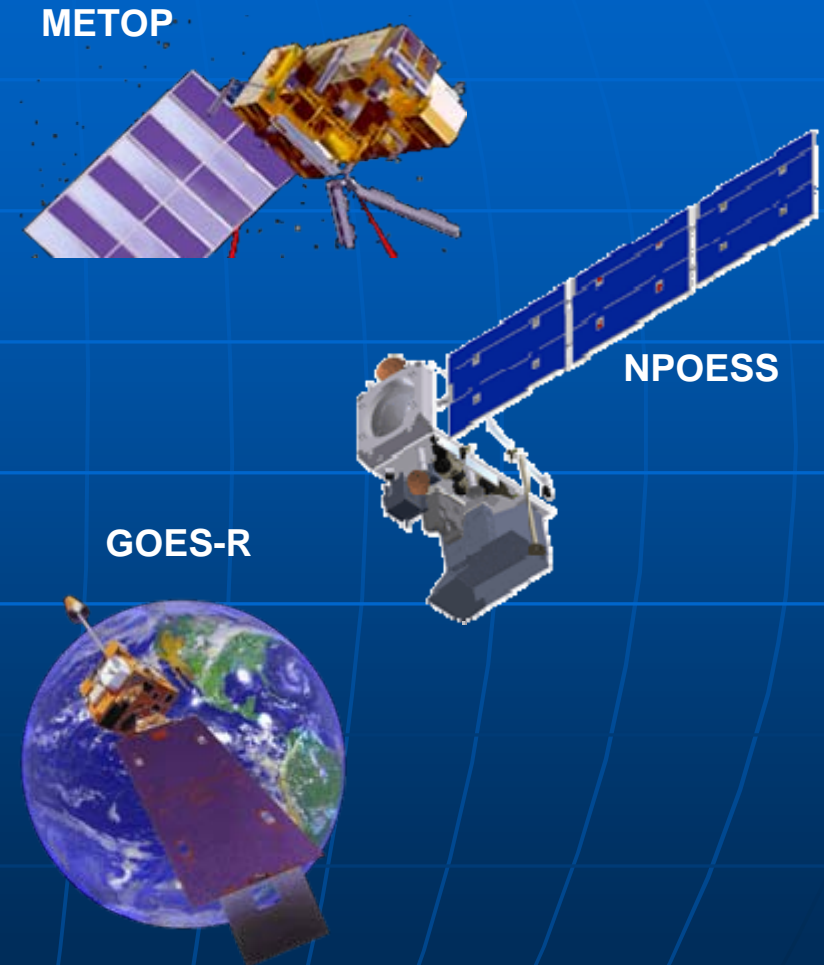
NASA Sounder Product Evaluation and Test Element (PEATE) Objectives and Approach

- **Objectives**
  - Evaluate Climate Worthiness of CrIMSS Products on NPP and NPOESS
  - Continue AIRS/AMSU NASA Unique Products using CriMSS on NPP and NPOESS
- **Approach**
  - Builds on AIRS Expertise, Algorithms and Capabilities at NASA, NOAA and Universities
  - JPL Selected as NPP Sounder PEATE
    - Unique experience as systems integrator of AIRS algorithm
    - Relationships with AIRS Science Team
    - Experience in data processing to support science investigations, software development, validation and L3/climate products

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Activities Needed to Facilitate
Future Operational Use

- **Assimilate more footprints and spectral channels of L1** (LeMarshall has this in his plan)
- **Transition to L2 Assimilation**
  - Cloud Cleared Radiances (Also in LeMarshall's plan)
  - Support Current L2 Geophysical Product Users: SPoRT, NOAA (Atlas), GLA
- **Improve L2 Accuracy (V5 and V6)**
  - Improved Surface Emissivity
    - Improves accuracy over land and polar regions
  - Make better use of AIRS Shortwave channels (non-LTE RTA)
    - Improves accuracy and resolution near the surface
- **Add Trace Gas Products (V5 and V6)**
  - Supports NASA/NOAA Joint Climate Research
- **Support Product Validation**
  - NASA: Field Campaigns, NASA Validation Activities, IPY
  - NOAA: Field Measurements, RaObs, RTGSST

Summary

- AIRS Instrument Calibration and Stability Facilitate Use in Operations
- Level 1 Products Developed by AIRS Science Team used in generation of radiances used for operations
- NOAA Distributes to NWP Centers worldwide for operational use
- AIRS Level 2 Products next step for operations
  - Numerous users currently evaluating products
- NASA continued support of NOAA sounding planned through PEATE for IASI, CrIS, and ultimately GOES-R